

greatest Heat for a quarter of an Hour ; when the Matter in the Crucible appeared fluid, like melted Glass. He then poured it out into an Iron Pan ; the Matter remained red hot some time ; when it was perfectly cold, it was hard, transparent, and brittle like common Glass ; but it soon began to relent, and in twenty-four Hours was almost all turned to Water again.

He said, “ If this *Vitrum Molle* be again entirely resolved in the Air, which will take up near fourteen Days time, by distilling off the Water, and letting the Remainder melt *per deliquium* again, ’till all the saltish Matter be resolved into Water, there remains an insipid whitish Earth, which fluxed in a Glass-Furnace, gives a true fixed Glass.”

II. *An Account of some Experiments upon the Phosphorus Urinæ, which may serve as an Explanation to those shewn to the Royal Society by Dr. Frobenius, on November 18, 1731, together with several Observations tending to explain the Nature of that wonderful Chemical Production, by Mr. Ambrose GODFREY Hanckewitz, Chemist, F. R. S.*

I Repeated the Experiment of the Deflagration of *Phosphorus* under a Bell, which had been first shewn to the *Royal Society* by Dr. *Frobenius*,
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but I found that a much more simple *Apparatus* was sufficient, than the pompous Machine he made use of. I took a strong wide-mouthed Glass Jar, which serves as a Stand for the Concave Glass Dish to rest on. In the Middle of the Glass Dish is a Hole communicating with a Pipe, which goes down into the above-mentioned Jar. Instead of the Golden Basons, a *China* Cup a little warmed, serves perfectly as well for burning off the *Phosphorus* : The last and main thing is a large Glass Bell, which fits nearly close upon the Glass Dish. This Bell may be easily lifted off and on with the Hands by an Assistant, without any Frame or Ropes to suspend it.

I took one Ounce of *Phosphorus*, which I deflagrated in the same manner as is described in Dr. *Frobenius's* Experiment, and obtained of the white sublimed Flowers ten Drachms, that is two Drachms more than the Weight of the *Phosphorus* before Deflagration : They were so very light as to their Volumen, that they just filled an half Pint Pot.

The ten Drachms of Flowers being set in a cool moist Place, exposed to the Air, did resolve into a *Liquamen*, weighing four Ounces and two Drachms, which *Liquamen* much resembles *Ol. Sulph. per Campanam* ; but contains an acid Salt, more fix'd in the Fire than any other Salt we know of in Nature, and having many other Properties peculiar to itself, which other acid Salts have not.

The *Phosphorus* receives this fix'd Acid from the Urine only ; for the Salt of Urine is so fix'd, that upon a live Charcoal with a blowing Pipe it plays and rolls about like Silver upon the Cupel.

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Whereas all other liquid Acids evaporate with Ease ; this on the contrary is so fix'd, as to require a greater Heat for its Evaporation than that which keeps Lead in Fusion ; and the *Phlogistick* Part, notwithstanding its Lightness, is so intimately and firmly connected with the rest of its Principles, as to sustain a Degree of Heat equal to that of red hot Iron, during which Heat the Salt sparkles and emits Flames very bright for a good while, which is very wonderful and agreeable to behold ; and this Sparkling being over, it remains red hot in Fusion, and perfectly transparent ; and by greater Heat may be vitrified, as will be shewn hereafter.

I put the above-mentioned *Liquamen* into a Glass Retort, which I set in a *Balneum Mariæ*, and distilled it to a strong Inspissation. It yielded only an insipid Phlegm, except that towards the last it came over a little impregnated with the Acid, but not sharper upon the Tongue than as if it had been a Mixture of Vinegar half an Ounce with Water four Ounces.

Then removing the Retort with the inspissated Liquor into a Sand-Furnace, I increased the Heat gradually, so as to make the Sand and Retort thoroughly red hot, 'till at last the Bottom of the Retort was ready to melt ; I then left it 'till next Day, when being perfectly cold, I broke the Retort, and found a most admirable white Salt at the Bottom, which was so united with the Glass as not to be separated from it ; and some was spread all over the Retort quite up to the Neck, and, as near as I could guess by View, it seemed to be as much in Quantity, could I have taken it out to weigh it, as the original *Phosphorus* from whence it was produc'd : Its Taste was very sharp

sharp and saline ; but notwithstanding its great Fixity in having endur'd a melting Heat for several Hours, it relented again in a moist Air, and in a few Days was entirely resolved into a *Liquamen*.

The *Phosphorus*, after its Deflagration, leaves an almost fix'd red Earth, or *Caput mortuum*, behind it, as is mention'd in Dr. *Frobenius's* Experiment. Although one would have imagin'd that all the inflammable Parts of the *Phosphorus* had been burnt off in the first Deflagration, which seem'd very violent, yet this red Earth retains so much of an unctious *Phlogistic*, that being placed over a red hot Fire, it swells up, and keeps in Fusion a great while, emitting Flames and Flashes of Light, so long as it is kept upon the Fire ; but when cold again, if exposed to a moist Air, it relents and resolves as the Flowers do : For the acid Salt of the Urine adheres so strongly to it, that although it undergoes several strong Ignitions, it will relent again as often, when set in the Air.

I took some of the white Salt that stuck to the Retort, and in order to try the utmost Degree of its Fixity, I put some of it into a Crucible, and gave it a vitrifying Heat, in which it remained some Hours, but was not yet run to Glass, appearing only like a fix'd white Earth as hard as Stone, and shining as if it was just ready to vitrify ; yet it was so far fix'd, as not to relent any more in the Air ; had no saline Taste, nor was dissolvable in Water. I therefore took another Portion of the same Salt of *Phosphorus*, which I kept a longer time in the vitrifying Heat, and I found it at last run into perfect Glass.

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Thus we see what a wonderful Subject is *Phosphorus*! And how surprising is it that such an inflammable Body, consisting of the unctuous and acid Parts of the Urine, should thus become Glass!

The Conclusion which I must now make from this remarkable Experiment is, That here is a perfect Transmutation of Bodies; the *Phosphorus* being transmuted into a fine transparent Glass of a bluish green Colour, coming nearer to the Hardness of a Diamond than any other Glass, and in the same Quantity as the *Phosphorus* at first used, which, without any Addition, produces this Glass Ounce for Ounce. Here I must stop, having brought these wonderful Experiments to a *ne plus ultra*.

I shall add here further, that the crude *Phosphorus*, without any Deflagration, but only cut very small, or scraped fine with a Knife, and laid upon a Glass Dish in moist Air, will in about a Week's time resolve into a *Liquamen* near eight times its original Weight: Which *Liquamen* is the same in all respects as that which comes from the sublimed Flowers by Deflagration, and may be vitrified likewise. In scraping the *Phosphorus*, take great Care not to do it too hastily, lest by heating it, you set it on fire.

REFLECTIONS on these EXPERIMENTS.

The Chemical *Phosphorus* being the principal Subject of the foregoing Experiments, I shall, upon this Occasion, give some Account of what *Phosphorus* is, and what it chiefly consists of. It is my Opinion, that *Phosphorus* doth not naturally exist
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in Animals by itself; but when formed out of Urine, by the Means of Putrefaction and Fire, its principal Contexture is found to consist of a subtile Acid concentrated by the Salt of Urine, and of a fat depurated Oil.

Phosphorus affords us so many wonderful *Phænomena*, that to explain them all would take up a large Treatise; a perfect *Phosphorologia*, being what would exceed the Limits of this short Account.

The *Phlogistic* Part is so slightly connected with the other Principles, that the least Motion, Friction or Warmth, sets it on fire.

The fixed Part seems to consist chiefly in the acid Salt of the Urine, which is at first so intimately concentrated with the *Phlogistic* Part, as in Deflagration to be hurried up or sublimed along with it; yet being by this Operation freed from it, it becomes fix'd, and can by no Degree of Heat be again sublimed.

Phosphorus may be called an urinous *Sapo*, or Soap, as it consists of the saline and oleaginous Parts of the Urine: But *Phosphorus* is not to be got in so great Plenty out of Urine alone, as when the *Fæces Alvinæ* are elixirated along with it, and then brought to a *Magma* fit for Distillation: Nor is there so great a Quantity of *Phosphorus* in the Urine of other Animals, as of Men; nor is it to be got from any Natural Productions, or any Parts of Animals or Vegetables in their crude State, before they have undergone Concoction in the Stomach of an Animal. How far therefore the *Liquor Gastricus*, the *Bile*,
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and *Succus Pancreaticus* may contribute to the Formation of it, is a Disquisition I shall not here enter upon, but leave it to the Enquiry of Physicians.

In regard of the Parts whereof *Phosphorus* consists, it may be considered as the Soot of a deflagrated Oil; and so may every combustible Substance be look'd upon as a kind of *Phosphorus*, as consisting of inflammable Materials.

Phosphorus is more immediately compounded of a Salt tending to the Nature of *Sal Ammoniac*, of an urinous Salt, of an Acid, and an oily *Phlogiston* with a subtile Earth; by the Means of these Salts existing in the Urine, the *Fæces Alvinæ* are the better elixirated, and those Particles extracted which contribute to the forming the *Phosphorus*. Concerning the Fixity of the urinous Salt, I have said enough already, so shall not repeat it here. With these Salts are very intimately combined in the *Phosphorus* oleaginous or fat Particles, which are the proper Materials of that subtile *Phlogiston*, the true *Domuncula Ignis*, and indeed the main Constituents of the whole Compound.

As for the Preparation of this wonderful Production, it is done by distilling the *Saponaceus Magma* in a close Vessel, with a reverberatory Fire, much stronger than that used for the Distillation of *Aquæ fortis*, or the other Mineral acid Spirits; the rest of the proper *Encheireses* belongs only to the Operator to manage *secundum Artem*. When this Operation succeeds rightly, there comes forth, First, a thick unctuous Oil. Secondly, a more subtile

tile Oil, resembling the *Oleum Philosophorum*, which is Olive Oil distilled from Brick-dust. Thirdly, The fix'd Acid enclosed in a very subtile Acid. Near the End of the Distillation comes over that depurated Oil which constitutes the inflamable Part of the *Phosphorus*, which is not raised up 'till the last, and that by the Continuance of a very strong Reverberatory Fire.

But an Operator that is not well exercised in the Degrees of Fire, and doth not know how and when to take away these Oils apart, will have nothing but a volatile Salt, and fetid Oil, and get at last only a little unctuous opaque *Phosphorus*; such as the famous *Kunckel*, Dr. *Crafft*, and *Brand* did, as they acknowledge in their Writings; but not our hard transparent *Glacial Phosphorus*. Since *Kunckel* therefore, and his Followers, were never able to make the true solid *Glacial Phosphorus*, it was absurd for him to write, that he could make it even out of crude indigested Things, in their natural State; for either this famous Man spoke too much at large, and had never tried the Experiments, or else he must design to impose upon the World: For I can boldly contradict him in this Point from the several Experiments I have made, but never found any true *Phosphorus* except in such things as had undergone Digestion in Animals. And I know my self to have been for these forty or fifty Years, that is, ever since I left the Laboratory of my Master the Honourable Mr. *Boyle*, the only Person in *Europe* able to make and produce in any Quantity the true solid *Phosphorus*,

I did not content my self to work upon the *Urinous Sapo* of Man only, but examined likewise the Excrements of other Animals; as for Example, of Horses, Cows, Sheep, &c. and got *Phosphorus*, but not in so great Quantities as from Man; probably because they feed on nothing but Vegetables. I then examin'd the Dens of Lions, Tygers, and Bears, making Experiments on their Excrements, and likewise on those of Cats and Dogs, which being carnivorous Animals, I obtain'd more *Phosphorus* thence than from the other Creatures: My Curiosity led me likewise to the Rats-Nests, and Mouse-Holes, and I had *Phosphorus* thence. I then address'd my self to the feather'd Tribe, visiting the Hen-Roosts, and Pidgeon-Houses, and got some small Matters thence also: I emptied the Guts of Fish in order to get their Excrements, and had a little *Phosphorus* from these, but none from the Fishes by themselves.

I was next induc'd by *Kunckel's* Assertion to try what I could obtain out of crude Vegetables, *viz.* Corn and other Fruit: I thought that Putrefaction would bring them the nighest to an *Ammoniac* and urinous State, because of the Heat that is produced in them by it; but my Labour was all in vain. After these Experiments, I took in Hand Fossils and Minerals: I began with the common Fossil Coal, thinking that the *Phlogiston* in this Bituminous Substance might have been to my Purpose; but I found nothing therein like *Phosphorus*, there coming over only a Bituminous Oil, and at last by encreasing the Fire to the highest Degree, there sublimed some white Talckly Flowers, which were neither Sulphureous,
nor

nor Acid, nor Alcalick, but insipid like Talck ; so I gave up all further Experiments upon other Minerals.

I have often wished for a sufficient Quantity of the Flies which shine in the Dark, whereof there are great Numbers in *Italy*, especially in *Tuscany* ; or of our common Glow-worms, which seem to have *Phosphorus* lodged in their Bodies.

Our *Phosphorus* is a Subject that occupies much the Thoughts and Fancies of some Alchymists, who work on Microcosmical Substances ; and out of it they promise themselves Golden Mountains. Of this Number was the famous Dr. *Dickinson*, Physician to King *Charles II* : He toiled and laboured many Years in Experiments upon the *Stercus humanum* ; and hath several times with the greatest Pleasure shew'd me *Metallic Regulus's*, he had extracted from it. This is what I have often done my self, and no Wonder ! for we take in daily with our Food, and sometimes in Medicines, both Mineral and Metallick Substances, besides what Metallick Vessels, Kettles, Pots and Dishes furnish : We see a Solution of the Metal upon a Knife after cutting any acid Fruit, by the black Spots it hath upon it, and the metallick Taste it communicates to the thing it cuts.

Dr. *Lifter* hath shewn, that Stones out of the Human Bladder being calcined, Iron may be extracted from them by a Loadstone. And the *Great Boerhaave* hath made it evident, by various Experiments, that there is scarce any terrestrial Substance, either in Men, Brutes or Plants, which after Ustion doth not exhibit some metallick Particles. Dr. *Becher* hath, that out of Brick-Earth mix'd with any Fat or Oil, and calcined in the Fire, he hath produced Iron :

Iron : For it is only the Iron that causes the Redness of the Bricks, and can be extracted from them again. Moreover, Metals are dissolved by the Salts and Moisture in the Earth, and so mix with the nutritious Juices of Vegetables; hence it may, in some respect, be said, that we eat Metals with the greatest Part of our Food.

Having given the foregoing short Account of the Production of *Phosphorus*, I shall here subjoin, that there is produced out of the *Residuum*, after the *Phosphorus* is made, a particular Salt, which I name *Sal-phosphori*, or Salt of *Phosphorus*. This Salt is fix'd in some Degrees of Fire, yet it may be sublimed in a close Vessel, which other fix'd Salts cannot be, except they still contain somewhat Volatile in them; but this Salt hath no such thing in it, neither is it any ways Alcalick.

How to produce this Salt, remains as much a Secret as the *Phosphorus* itself; for he that cannot produce this Salt will never be able to make *Phosphorus*.

There is scarce any Body, out of which a Chemical Operator cannot produce Water and Earth, Salts, or an acid Spirit, and an urinous Unctuousity, in more or less Quantity, according to the Nature of the Body; and where there is one of these, there is Fire to be demonstrated, but not without each other's Help. The *Encheirids* of this would be too long for this Place, I shall therefore omit it here.

From our Preparation of *Phosphorus*, we may reflect upon the *Fuligo*, or Soot of all combustible Substances; for it is the *Phlogiston* only that burns and produces Flame; it dwells in sulphureous Bodies,

dies, and unctuous Earths, in Pitch, Rosin, Wax and Oils; and in the Fat of Animals: But the finest exists in ardent Spirits, which when brought to that surprizing Subtily, as that Liquor described by Dr. *Frobenius* in Transact. N^o 413, do truly deserve the Name of *Æther*.

OBSERVATIONS on the PHOSPHORUS.

I. From what hath been said, we see that the *Saponaceous Magma* of Urine has great Affinity with common Sulphur; being a sulphureous Body, composed of an acid and depurated Oil, join'd with a small Proportion of Earth.

II. Our *Phosphoreal Magma* comes very near *Homberg's Pyrophorus*, which wants only the Salt of Urine in it, in the room of which Allum is used to fix the Sulphur.

III. We may observe hence, that urinous Particles exist in greater abundance in Animals; but the *Phlogiston* abounds most in Vegetables, from which is prepared that fine *Æthereal Spirit* shewn by Dr. *Frobenius*.

IV. We produce the *Phlogiston* out of fat Substances, and from the *Phlogiston* a *Fuligo*, or Soot, and from the *Fuligo* an urinous Salt.

V. From the corrosive Oil of Sulphur, we have a pure subtile Oil, which is intimately combined with it, and is the actual Fire of the *Phosphorus*, that by barely rubbing, or the least Degree of Heat, is kindled into Flame.

VI. He

VI. He who knows perfectly the Method of making *Phosphorus*, can choose whether he will sublime his *Magma* of Urine into *Phosphorus*, or into Sulphur; for the Difference consists only in the *Encheiresis*.

III. *Observations of the Appearances among the Fix'd Stars, called Nebulous Stars. By W. Derham, D. D. Canon of Windsor, F. R. S.*

HAVING last Autumn made some good Observations, with my eight Foot Reflecting Telescope, of the Appearances in the Heavens, called *Nebulous Stars*, I think it proper to acquaint this Illustrious Society with them, to instigate others to make farther Observations of them, because I think there is much more in them worthy of the Inquiry of the Curious, than hath hitherto been imagined, and because I fear I shall not be able to pursue my Observations much farther, by reason my Reflector loseth its Excellence and Power, by beginning to be tarnished.

But if any one would have a good View of these *Nebulosæ*, it is of absolute Necessity that he makes use of very good Glasses, else all his Labour will be lost, as I found by Experience.

These Appearances in the Heavens, have born the Name of *Nebulous Stars*: But neither are they *Stars*, nor such Bodies as emit, or reflect Light, as the